DIAZABICYCLONONENE DERIVATIVES AND THEIR USE AS RENIN INHIBITORS

The invention relates to novel five-membered heteroaryl derivatives of the general formula (I). The invention also concerns related aspects including processes for the preparation of the compounds, pharmaceutical compositions containing one or more compounds of formula (I) and especially their use as renin inhibitors in cardiovascular events and renal insufficiency.

In the renin-angiotensin system (RAS) the biologically active angiotensin II (Ang II) is generated by a two-step mechanism. The highly specific enzyme renin cleaves angiotensinogen to angiotensin I (Ang I), which is then further processed to Ang II by the less specific angiotensin-converting enzyme (ACE). Ang II is known to work on at least two receptor subtypes called AT_1 and AT_2. Whereas AT_1 seems to transmit most of the known functions of Ang II, the role of AT_2 is still unknown.

Modulation of the RAS represents a major advance in the treatment of cardiovascular diseases. ACE inhibitors and AT_1 blockers have been accepted to treat hypertension (Waeber B. *et al.*, "The renin-angiotensin system: role in experimental and human hypertension", in Berkenhager W. H., Reid J. L. (eds): *Hypertension*, Amsterdam, Elsevier Science Publishing Co, **1996**, 489-519; Weber M. A., *Am. J. Hypertens.*, **1992**, *5*, 247S). In addition, ACE inhibitors are used for renal protection (Rosenberg M. E. *et al.*, *Kidney International*, **1994**, *45*, 403; Breyer J. A. *et al.*, *Kidney International*, **1994**, *45*, S156), in the prevention of congestive heart failure (Vaughan D. E. *et al.*, *Cardiovasc. Res.*, **1994**, *28*, 159; Fouad-Tarazi F. *et al.*, *Am. J. Med.*, **1988**, *84 (Suppl. 3A)*, 83) and myocardial infarction (Pfeffer M. A. *et al.*, *N. Engl. J. Med.*, **1992**, *327*, 669).

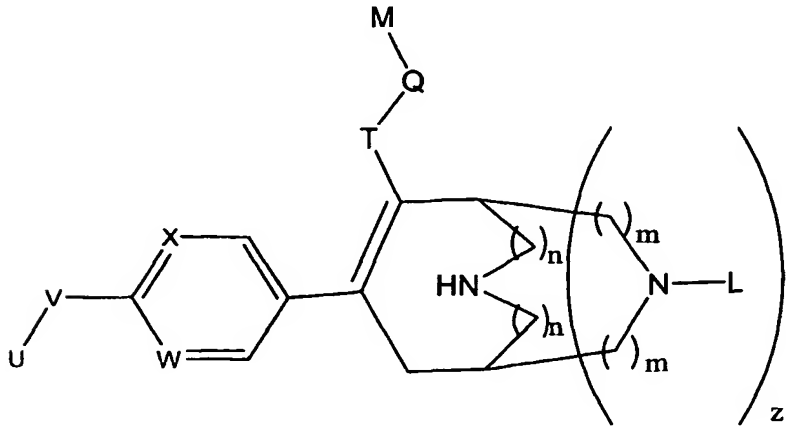
The rationale to develop renin inhibitors is the specificity of renin (Kleinert H. D., *Cardiovasc. Drugs*, **1995**, *9*, 645). The only substrate known for renin is angiotensinogen, which can only be processed (under physiological conditions) by renin. In contrast, ACE can also cleave bradykinin besides Ang I and can be by-passed by chymase, a serine protease (Husain A., *J. Hypertens.*, **1993**, *11*, 1155). In patients inhibition of ACE thus leads to bradykinin accumulation causing cough (5-20%) and potentially life-threatening angioneurotic edema (0.1-0.2%) (Israili Z. H. *et al.*, *Annals of Internal Medicine*, **1992**, *117*, 234). Chymase is not inhibited by ACE inhibitors. Therefore, the formation of Ang II is still possible in patients treated with ACE inhibitors. Blockade of the AT_1 receptor (e.g.

by losartan) on the other hand overexposes other AT-receptor subtypes (e.g. AT_2) to Ang II, whose concentration is significantly increased by the blockade of AT_1 receptors. In summary, renin inhibitors are expected to demonstrate a different pharmaceutical profile than ACE inhibitors and AT_1 blockers with regard to efficacy in blocking the RAS and in safety aspects.

Only limited clinical experience (Azizi M. *et al.*, *J. Hypertens.*, **1994**, *12*, 419; Neutel J. M. *et al.*, *Am. Heart*, **1991**, *122*, 1094) has been created with renin inhibitors because of their insufficient oral activity due to their peptidomimetic character (Kleinert H. D., *Cardiovasc. Drugs*, **1995**, *9*, 645). The clinical development of several compounds has been stopped because of this problem together with the high cost of goods. Only one compound containing four chiral centers has entered clinical trials (Rahuel J. *et al.*, *Chem. Biol.*, **2000**, *7*, 493; Mealy N. E., *Drugs of the Future*, **2001**, *26*, 1139). Thus, renin inhibitors with good oral bioavailability and long duration of action are required. Recently, the first non-peptide renin inhibitors were described which show high *in vitro* activity (Oefner C. *et al.*, *Chem. Biol.*, **1999**, *6*, 127; Patent Application WO97/09311; Märki H. P. *et al.*, *Il Farmaco*, **2001**, *56*, 21). However, the development status of these compounds is not known.

The present invention relates to the identification of renin inhibitors of a non-peptidic nature and of low molecular weight. Described are orally active renin inhibitors of long duration of action which are active in indications beyond blood pressure regulation where the tissular renin-chymase system may be activated leading to pathophysiologically altered local functions such as renal, cardiac and vascular remodeling, atherosclerosis, and possibly restenosis. So, the present invention describes these non-peptidic renin inhibitors. The present invention describes non-peptidic renin inhibitors.

In particular, the present invention relates to novel compounds of the general formula **I**,



Formula **I**

wherein

X and W represent independently a nitrogen atom or a -CH- group;

V represents $-(CH_2)_r-$; $-A-(CH_2)_s-$; $-CH_2-A-(CH_2)_t-$; $-(CH_2)_s-A-$; $-(CH_2)_2-A-(CH_2)_u-$; $-A-(CH_2)_v-B-$; $-CH_2-CH_2-CH_2-A-CH_2-$; $-A-CH_2-CH_2-B-CH_2-$; $-CH_2-A-CH_2-CH_2-B-$; $-CH_2-CH_2-CH_2-A-CH_2-CH_2-$; $-CH_2-CH_2-CH_2-CH_2-A-CH_2-$; $-A-CH_2-CH_2-B-CH_2-CH_2-$; $-CH_2-A-CH_2-CH_2-B-CH_2-$; $-CH_2-A-CH_2-CH_2-CH_2-B-$; or $-CH_2-CH_2-A-CH_2-CH_2-B-$;

A and B independently represent -O-; -S-; -SO-; $-SO_2-$;

U represents aryl; heteroaryl;

T represents $-CONR^1-$; $-(CH_2)_pOCO-$; $-(CH_2)_pN(R^1)CO-$; $-(CH_2)_pN(R^1)SO_2-$; or -COO-;

Q represents lower alkylene; lower alkenylene;

M represents aryl-$O(CH_2)_vR^5$; heteroaryl-$O(CH_2)_vR^5$; aryl-$O(CH_2)_2O(CH_2)_wR^5$; heteroaryl-$(CH_2)_2O(CH_2)_wR^5$;

L represents $-R^3$; $-COR^3$; $-COOR^3$; $-CONR^2R^3$; $-SO_2R^3$; $-SO_2NR^2R^3$; $-COCH(Aryl)_2$;

R^1 represents hydrogen; lower alkyl; lower alkenyl; lower alkinyl; cycloalkyl; aryl; cycloalkyl - lower alkyl;

R^2 and $R^{2'}$ independently represent hydrogen; lower alkyl; lower alkenyl; cycloalkyl; cycloalkyl - lower alkyl;

R^3 represents hydrogen; lower alkyl; lower alkenyl; cycloalkyl; aryl; heteroaryl; heterocyclyl; cycloalkyl - lower alkyl; aryl - lower alkyl; heteroaryl - lower alkyl; heterocyclyl - lower alkyl; aryloxy - lower alkyl; heteroaryloxy - lower alkyl, whereby these groups may be unsubstituted or mono-, di- or trisubstituted with hydroxy, $-OCOR^2$, $-COOR^2$, lower alkoxy, cyano, $-CONR^2R^{2'}$, CO-morpholin-4-yl, CO-((4-loweralkyl)piperazin-1-yl), $-NH(NH)NH_2$, $-NR^4R^{4'}$ or lower alkyl, with the proviso that a carbon atom is attached at the most to one heteroatom in case this carbon atom is sp3-hybridized;

R^4 and $R^{4'}$ independently represent hydrogen; lower alkyl; cycloalkyl; cycloalkyl - lower alkyl; hydroxy - lower alkyl; $-COOR^2$; $-CONH_2$;

R^5 represents –OH, $-OCOR^2$, $-COOR^2$, $-NR^2R^{2'}$, $-OCONR^2R^{2'}$, $-NCONR^2R^{2'}$, cyano, $-CONR^2R^{2'}$, SO_3H, $-SONR^2R^{2'}$, -CO-morpholin-4-yl, -CO-((4-loweralkyl)piperazin-1-yl), $-NH(NH)NH_2$, $-NR^4R^{4'}$, with the proviso that a carbon atom is attached at the most to one heteroatom in case this carbon atom is sp3-hybridized;

m and n represent the integer 0 or 1, with the proviso that in case m represents the integer 1, n is the integer 0, and in case n represents the integer 1, m is the integer 0;

p is the integer 1, 2, 3 or 4;

r is the integer 3, 4, 5, or 6;

s is the integer 2, 3, 4, or 5;

t is the integer 1, 2, 3, or 4;

u is the integer 1, 2, or 3;

v is the integer 2, 3, or 4;

w is the integer 1 or 2;

z is the integer 0 or 1; if z represents the integer 0, n represents the integer 0.

In addition optically pure enantiomers, mixtures of enantiomers such as racemates, diastereomers, mixtures of diastereomers, diastereomeric racemates, mixtures of diastereomeric racemates, and the meso-form; as well as pharmaceutically acceptable salts, solvent complexes and morphological forms are also encompassed by the present invention.

In the definitions of general formula **I** – if not otherwise stated – the term **lower alkyl**, alone or in combination with other groups, means saturated, straight and branched chain groups with one to seven carbon atoms, preferably one to four carbon atoms that can be optionally substituted by halogens. Examples of lower alkyl groups are methyl, ethyl, n-propyl, iso-propyl, n-butyl, iso-butyl, sec-butyl, tert-butyl, pentyl, hexyl and heptyl. The methyl, ethyl nad isopropyl groups are preferred.

The term **lower alkoxy** refers to a R-O group, wherein R is a lower alkyl. Examples of lower alkoxy groups are methoxy, ethoxy, propoxy, iso-propoxy, iso-butoxy, sec-butoxy and tert-butoxy.

The term **lower alkenyl**, alone or in combination with other groups, means straight and branched chain groups comprising an olefinic bond and consisting of two to seven carbon atoms, preferably two to four carbon atoms, that can be optionally substituted by halogens. Examples of lower alkenyl are vinyl, propenyl or butenyl.

The term **lower alkinyl**, alone or in combination with other groups, means straight and branched chain groups comprising a triple bond and consisting of two to seven carbon atoms, preferably two to four carbon atoms, that can be optionally substituted by halogens. Examples of lower alkinyl are ethinyl, propinyl or butinyl.

The term **lower alkylene**, alone or in combination with other groups, means straight and branched divalent chain groups with one to seven carbon atoms, preferably one to four

carbon atoms, that can be optionally substituted by halogens. Examples of lower alkylene are methylene, ethylene, propylene or butylene.

The term **lower alkenylene**, alone or in combination with other groups, means straight and branched divalent chain groups comprising an olefinic bond and consisting of two to seven carbon atoms, preferably two to four carbon atoms, that can be optionally substituted by halogens. Examples of lower alkenylene are vinylene, propenylene and butenylene.

The term **lower alkylenedioxy**, refers to a lower alkylene substituted at each end by an oxygen atom. Examples of lower alkylenedioxy groups are preferably methylenedioxy and ethylenedioxy.

The term **lower alkylenoxy** refers to a lower alkylene substituted at one end by an oxygen atom. Examples of lower alkylenoxy groups are preferably methylenoxy, ethylenoxy and propylenoxy.

The term **halogen** means fluorine, chlorine, bromine or iodine, preferably fluorine, chlorine and bromine.

The term **cycloalkyl** alone or in combination, means a saturated cyclic hydrocarbon ring system with 3 to 7 carbon atoms, e.g. cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl and cycloheptyl, which can be optionally mono- or multisubstituted by lower alkyl, lower alkenyl, lower alkenylene, lower alkoxy, lower alkylenoxy, lower alkylenedioxy, hydroxy, halogen, $-CF_3$, $-NR^1R^{1'}$, $-NR^1C(O)R^{1'}$, $-NR^1S(O_2)R^{1'}$, $-C(O)NR^1R^{1'}$, lower alkylcarbonyl, $-COOR^1$, $-SR^1$, $-SOR^1$, $-SO_2R^1$, $-SO_2NR^1R^{1'}$ whereby $R^{1'}$ represents hydrogen; lower alkyl; lower alkenyl; lower alkinyl; cycloalkyl; aryl; cycloalkyl - lower alkyl. The cyclopropyl group is a preferred group.

The term **aryl**, alone or in combination, relates to the phenyl, the naphthyl or the indanyl group, preferably the phenyl group, which can be optionally mono- or multisubstituted by lower alkyl, lower alkenyl, lower alkinyl, lower alkenylene or lower alkylene forming with the aryl ring a five- or six-membered ring, lower alkoxy, lower alkylenedioxy, lower alkylenoxy, hydroxy, hydroxy-lower alkyl, halogen, cyano, $-CF_3$, $-OCF_3$, $-NR^1R^{1'}$, $-NR^1R^{1'}$ - lower alkyl, $-NR^1C(O)R^{1'}$, $-NR_1S(O_2)R^1$, $-C(O)NR^1R^{1'}$, $-NO_2$, lower alkylcarbonyl, $-COOR^1$, $-SR^1$, $-SOR^1$, $-SO_2R^1$, $-SO_2NR^1R^{1'}$, benzyloxy, whereby $R^{1'}$ has the meaning given above. Preferred substituents are halogen, lower alkoxy, lower alkyl, CF_3, OCF_3.

For the the substituent U, the term aryl means 2,6-dichloro-4-methylphenyl or 2-chloro-3,6-difluorophenyl.

The term **aryloxy** refers to an Ar-O group, wherein Ar is an aryl. An example of a lower aryloxy group is phenoxy.

The term **heterocyclyl**, alone or in combination, means saturated or unsaturated (but not aromatic) five-, six- or seven-membered rings containing one or two nitrogen, oxygen or sulfur atoms which may be the same or different and which rings can be optionally substituted with lower alkyl, hydroxy, lower alkoxy and halogen. The nitrogen atoms, if present, can be substituted by a $-COOR^2$ group. Examples of such rings are piperidinyl, morpholinyl, thiomorpholinyl, piperazinyl, tetrahydropyranyl, dihydropyranyl, 1,4-dioxanyl, pyrrolidinyl, tetrahydrofuranyl, dihydropyrrolyl, imidazolidinyl, dihydropyrazolyl, pyrazolidinyl, dihydroquinolinyl, tetrahydroquinolinyl, tetrahydroisoquinolinyl.

The term **heteroaryl**, alone or in combination, means six-membered aromatic rings containing one to four nitrogen atoms; benzofused six-membered aromatic rings containing one to three nitrogen atoms; five-membered aromatic rings containing one oxygen, one nitrogen or one sulfur atom; benzofused five-membered aromatic rings containing one oxygen, one nitrogen or one sulfur atom; five-membered aromatic rings containing one oxygen and one nitrogen atom and benzofused derivatives thereof; five-membered aromatic rings containing a sulfur and a nitrogen or an oxygen atom and benzofused derivatives thereof; five-membered aromatic rings containing two nitrogen atoms and benzofused derivatives thereof; five-membered aromatic rings containing three nitrogen atoms and benzofused derivatives thereof, or a tetrazolyl ring. Examples of such ring systems are furanyl, thiophenyl, pyrrolyl, pyridinyl, pyrimidinyl, indolyl, quinolinyl, isoquinolinyl, imidazolyl, triazinyl, thiazinyl, thiazolyl, isothiazolyl, pyridazinyl, pyrazolyl, oxazolyl, isoxazolyl, coumarinyl, benzothiophenyl, quinazolinyl, quinoxalinyl. Such rings may be adequatly substituted with lower alkyl, lower alkenyl, lower alkinyl, lower alkylene, lower alkenylene, lower alkylenedioxy, lower alkyleneoxy, hydroxy-lower alkyl, lower alkoxy, hydroxy, halogen, cyano, $-CF_3$, $-OCF_3$, $-NR^1R^{1'}$, $-NR^1R^{1'}$ - lower alkyl, $-N(R^1)COR^1$, $-N(R^1)SO_2R^1$, $-CONR^1R^{1'}$, $-NO_2$, lower alkylcarbonyl, $-COOR^1$, $-SR^1$, $-SOR^1$, $-SO_2R^1$, $-SO_2NR^1R^{1'}$, another aryl, another heteroaryl or another heterocyclyl and the like, whereby $R^{1'}$ has the meaning given above.

For the substituent M, the term heteroaryl means 3-methylpyridin-4-yl.

The term **heteroaryloxy** refers to a Het-O group, wherein Het is a heteroaryl.

The term **cycloalkyl - lower alkyl** refers to a cycloalkyl group as defined above which is substituted with a lower alkyl group.

The term **aryl - lower alkyl** refers to to an aryl group as defined above which is substituted with a lower alkyl group.

The term **heteroaryl - lower alkyl** refers to to a heteroaryl group as defined above which is substituted with a lower alkyl group.

The term **heterocyclyl - lower alkyl** refers to a heterocyclyl group as defined above which is substituted with a lower alkyl group.

The term **aryloxy - lower alkyl** refers to to a Ar-O group as defined above which is substituted with a lower alkyl group.

The term **heteroaryloxy - lower alkyl** refers to to a Het-O group as defined above which is substituted with a lower alkyl group.

The term **hydroxy - lower alkyl** refers to to a lower alkyl group as defined above which is substituted with a hydroxyl group.

The term **lower alkylcarbonyl** refers to a lower alkyl-CO- group.

The term **sp3-hybridized** refers to a carbom atom and means that this carbon atom forms four bonds to four substituents placed in a tetragonal fashion around this carbon atom.

The expression **pharmaceutically acceptable** salts encompasses either salts with inorganic acids or organic acids like hydrochloric or hydrobromic acid, sulfuric acid, phosphoric acid, citric acid, formic acid, acetic acid, maleic acid, tartaric acid, benzoic acid, methanesulfonic acid, p-toluenesulfonic acid, and the like that are non toxic to living organisms or in case the compound of formula **I** is acidic in nature with an inorganic base like an alkali or earth alkali base, e.g. sodium hydroxide, potassium hydroxide, calcium hydroxide and the like.

The compounds of the general formula **I** can contain two or more asymmetric carbon atoms and may be prepared in form of optically pure enantiomers, mixtures of enantiomers such as racemates, diastereomers, mixtures of diastereomers, diastereomeric racemates, mixtures of diastereomeric racemates, and the meso-form and pharmaceutically acceptable salts therof.

The present invention encompasses all these forms. Mixtures may be separated in a manner known *per se*, i.e. by column chromatography, thin layer chromatography, HPLC or crystallization.

A group of preferred compounds are compounds of general formula **I** wherein X, W, V, U, T, Q, L, and M are as defined in general formula **I** above and wherein

z is 1,

n is 0 and

m is 1.

Another group of preferred compounds of general formula I are those wherein X, W, V, U, T, Q, M, m, and n are as defined in general formula I above and

z is 1 and

L represents H; $-COR^{3''}$; $-COOR^{3''}$; $-CONR^{2''}R^{3''}$;

whereby $R^{2''}$ and $R^{3''}$ represent independently lower alkyl, cycloalkyl - lower alkyl, which lower alkyl and cycloalkyl - lower alkyl groups are unsubstituted or monosubstituted with halogen, cyano, hydroxy, $-OCOCH_3$, $-CONH_2$, -COOH, $-NH_2$, with the proviso that a carbon atom is attached at the most to one heteroatom in case this carbon atom is sp3-hybridized.

Another group of preferred compounds of general formula I above are those wherein X, W, V, U, L, m, n, and z are as defined in general formula I and

T is $-CONR^1-$;

Q is methylene;

M is aryl-$O(CH_2)_vR^5$; heteroaryl-$O(CH_2)_vR^5$; aryl-$O(CH_2)_2O(CH_2)_wR^5$; heteroaryl-$(CH_2)_2O(CH_2)_wR^5$.

Another group of even more preferred compounds of general formula I are those wherein X, W, U, L, T, Q, M, m, n, and z are as defined in general formula I above and

V represents $-CH_2CH_2O-$; $-CH_2CH_2CH_2O-$; $-OCH_2CH_2O-$; $-O-CH_2-CH_2-$; $-O-CH_2-CH_2-CH_2-$.

Another group of also more preferred compounds of general formula I are those wherein V, U, T, Q, M, L, m, n, and z are as defined in general formula I above and

X and W represent -CH-.

Another group of also more preferred compounds of general formula I are those wherein X, W, V, Q, T, M, L, m, n, and z are as defined in general formula I above and

U is a mono-, di-, or trisubstituted phenyl wherein the substituents are halogen; lower alkyl or lower alkoxy.

Most preferred compounds of formula I are those wherein

U represents a mono-, di-, or tri- substituted phenyl ring independently substituted with halogen or C1-C4 alkyl;

V represents $-O-CH_2-CH_2-CH_2-$; $-O-CH_2-CH_2-O-$; $-O-CH_2-CH_2-$; $-CH_2-CH_2-O-$; $-O-CH_2-CH_2-CH_2-O-$; $-CH_2-CH_2-CH_2-O-$;

X and W represent a –CH- group;

T represents $-CONR^1-$, wherein R^1 is a cycloalkyl group;

Q represents $-CH_2-$;

M represents a substituted pyridyl-$O(CH_2)_vR^5$ group substituted with C1-C4 alkyl, wherein R^5 is hydroxyl; $-COOR_2$, wherein R^2 is hydrogen or C1-C4 alkyl; or R^5 is $-CONR^2R^{2'}$, wherein R^2 and $R^{2'}$ are hydrogen or C1-C4 alkyl and $_v$ is the integer 2 or 3;

L represents hydrogen;

n is the integer 0;

z is the integer 1; and

m is the integer 1.

Additional most preferred compounds of formula I are those wherein

U represents a tri-substituted phenyl ring substituted independently with halogen or a phenyl ring substituted in 2- and 6- position with chloro and in 4-position with a methyl group;

V represents $-O-CH_2-CH_2-CH_2-$; $-O-CH_2-CH_2-O-$;

X and W represent a –CH- group;

T represents $-CONR^1-$, wherein R^1 is a cyclopropyl group;

Q represents $-CH_2-$;

M represents a pyridinyl-$O(CH_2)_vR^5$ group, whereby the pyridinyl ring is substituted with a methyl group, wherein R^5 represents hydroxyl; and $_v$ is the integer 2 or 3;

L represents hydrogen;

n is the integer 0;

z is the integer 1; and

m is the integer 1.

Especially preferred compounds of general formula **I** are those selected from the group consisting of:

(rac.)-(*1R**, *5S**)-7-{4-[3-(2-chloro-3,6-difluorophenoxy)propyl]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-6-carboxylic acid cyclopropyl-[2-(3-hydroxy-propoxy)-3-methylpyridin-4-ylmethyl]amide;

(rac.)-(*1R**, *5S**)-7-{4-[2-(2,6-dichloro-4-methylphenoxy)ethoxy]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-6-carboxylic acid cyclopropyl-[2-(3-hydroxy-propoxy)-3-methylpyridin-4-ylmethyl]amide;

(rac.)-(*1R**, *5S**)-7-{4-[3-(2-chloro-3,6-difluorophenoxy)propyl]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-6-carboxylic acid cyclopropyl-[2-(2-hydroxy-ethoxy)-3-methylpyridin-4-ylmethyl]amide;

(rac.)-(*1R**, *5S**)-7-{4-[2-(2,6-dichloro-4-methylphenoxy)ethoxy]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-6-carboxylic acid cyclopropyl-[2-(2-hydroxy-ethoxy)-3-methylpyridin-4-ylmethyl]amide.

The invention relates to a method for the treatment and/or prophylaxis of diseases which are related to hypertension, congestive heart failure, pulmonary hypertension, renal insufficiency, renal ischemia, renal failure, renal fibrosis, cardiac insufficiency, cardiac hypertrophy, cardiac fibrosis, myocardial ischemia, cardiomyopathy, glomerulonephritis, renal colic, complications resulting from diabetes such as nephropathy, vasculopathy and neuropathy, glaucoma, elevated intra-ocular pressure, atherosclerosis, restenosis post angioplasty, complications following vascular or cardiac surgery, erectile dysfunction, hyperaldosteronism, lung fibrosis, scleroderma, anxiety, cognitive disorders, complications of treatments with immunosuppressive agents, and other diseases known to be related to the renin-angiotensin system, which method comprises administrating a compound as defined above to a human being or animal.

In another embodiment, the invention relates to a method for the treatment and/or prophylaxis of diseases which are related to hypertension, congestive heart failure, pulmonary hypertension, renal insufficiency, renal ischemia, renal failure, renal fibrosis, cardiac insufficiency, cardiac hypertrophy, cardiac fibrosis, myocardial ischemia, cardiomyopathy, complications resulting from diabetes such as nephropathy, vasculopathy and neuropathy.

In another embodiment, the invention relates to a method for the treatment and/or prophylaxis of diseases, which are associated with a dysregulation of the renin-angiotensin system as well as for the treatment of the above-mentioned diseases.

The invention also relates to the use of compounds of formula (I) for the preparation of a medicament for the treatment and/or prophylaxis of the above-mentioned diseases.

A further aspect of the present invention is related to a pharmaceutical composition containing at least one compound according to general formula (I) and pharmaceutically acceptable carrier materials or adjuvants. This pharmaceutical composition may be used for the treatment or prophylaxis of the above-mentioned disorders; as well as for the preparation of a medicament for the treatment and/or prophylaxis of the above-mentioned diseases.

Derivatives of formula (I) or the above–mentioned pharmaceutical compositions are also of use in combination with other pharmacologically active compounds comprising ACE-inhibitors, neutral endopeptidase inhibitors, angiotensin II receptor antagonists, endothelin

receptors antagonists, vasodilators, calcium antagonists, potassium activators, diuretics, sympatholitics, beta-adrenergic antagonists, alpha-adrenergic antagonists or with other drugs beneficial for the prevention or the treatment of the above-mentioned diseases.

In a preferred embodiment, this amount is comprised between 2 mg and 1000 mg per day.

In a particular preferred embodiment, this amount is comprised between 1 mg and 500 mg per day.

In a more particularly preferred embodiment, this amount is comprised between 5 mg and 200 mg per day.

All forms of prodrugs leading to an active component comprised by general formula (I) above are included in the present invention.

Compounds of formula (I) and their pharmaceutically acceptable acid addition salts can be used as medicaments, e. g. in the form of pharmaceutical compositions containing at least one compound of formula (I) and pharmaceutically acceptable inert carrier material or adjuvants. These pharmaceutical compositions can be used for enteral, parenteral, or topical administration. They can be administered, for example, perorally, e. g. in the form of tablets, coated tablets, dragées, hard and soft gelatine capsules, solutions, emulsions or suspensions, rectally, e. g. in the form of suppositories, parenterally, e. g. in the form of injection solutions or infusion solutions, or topically, e. g. in the form of ointments, creams or oils.

The production of pharmaceutical preparations can be effected in a manner which will be familiar to any person skilled in the art by bringing the described compounds of formula (I) and their pharmaceutically acceptable acid addition salts, optionally in combination with other therapeutically valuable substances, into a galenical administration form together with suitable, non-toxic, inert, therapeutically compatible solid or liquid carrier materials and, if desired, usual pharmaceutical adjuvants.

Suitable carrier materials are not only inorganic carrier materials, but also organic carrier materials. Thus, for example, lactose, corn starch or derivatives thereof, talc, stearic acid or its salts can be used as carrier materials for tablets, coated tablets, dragées and hard gelatine capsules. Suitable carrier materials for soft gelatine capsules are, for example, vegetable oils, waxes, fats and semi-solid and liquid polyols (depending on the nature of the active ingredient no carriers are, however, required in the case of soft gelatine capsules). Suitable carrier materials for the production of solutions and syrups are, for example, water, polyols, sucrose, invert sugar and the like. Suitable carrier materials for injections are, for example, water, alcohols, polyols, glycerols and vegetable oils. Suitable

carrier materials for suppositories are, for example, natural or hardened oils, waxes, fats and semi-liquid or liquid polyols. Suitable carrier materials for topical preparations are glycerides, semi-synthetic and synthetic glycerides, hydrogenated oils, liquid waxes, liquid paraffins, liquid fatty alcohols, sterols, polyethylene glycols and cellulose derivatives.

Usual stabilizers, preservatives, wetting and emulsifying agents, consistency-improving agents, flavour-improving agents, salts for varying the osmotic pressure, buffer substances, solubilizers, colorants and masking agents and antioxidants come into consideration as pharmaceutical adjuvants.

The dosage of compounds of formula (I) can vary within wide limits depending on the disease to be controlled, the age and the individual condition of the patient and the mode of administration, and will, of course, be fitted to the individual requirements in each particular case.

Another aspect of the invention is related to a process for the preparation of a pharmaceutical composition comprising a derivative of the general formula (I). According to said process, one or more active ingredients of the general formula (I) are mixing with inert excipients in a manner known *per se.*

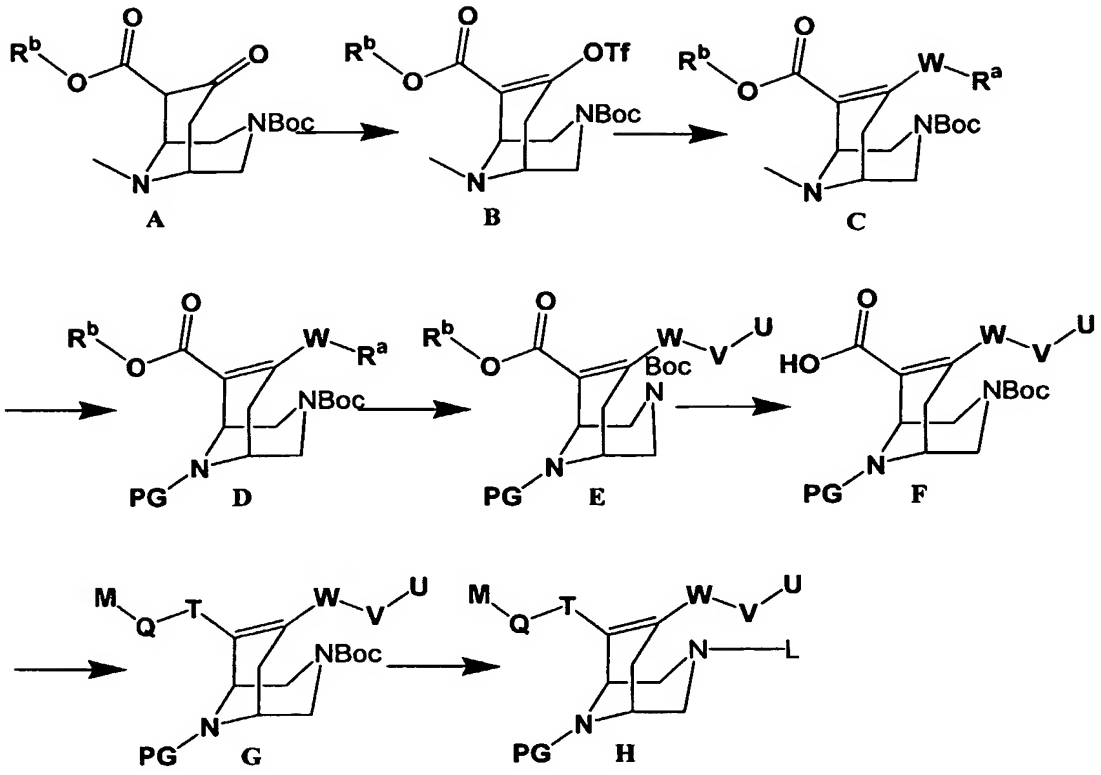
The compounds of general formula **I** can be manufactured by the methods outlined below, by the methods described in the examples or by analogous methods.

Preparation of the precursors:

Precursors are compounds which were prepared as key intermediates and/or building blocks and which were suitable for further transformations in parallel chemistry. Most of the chemistry applyable here has already been described in the patent applications WO03/093267 and WO04/002957.

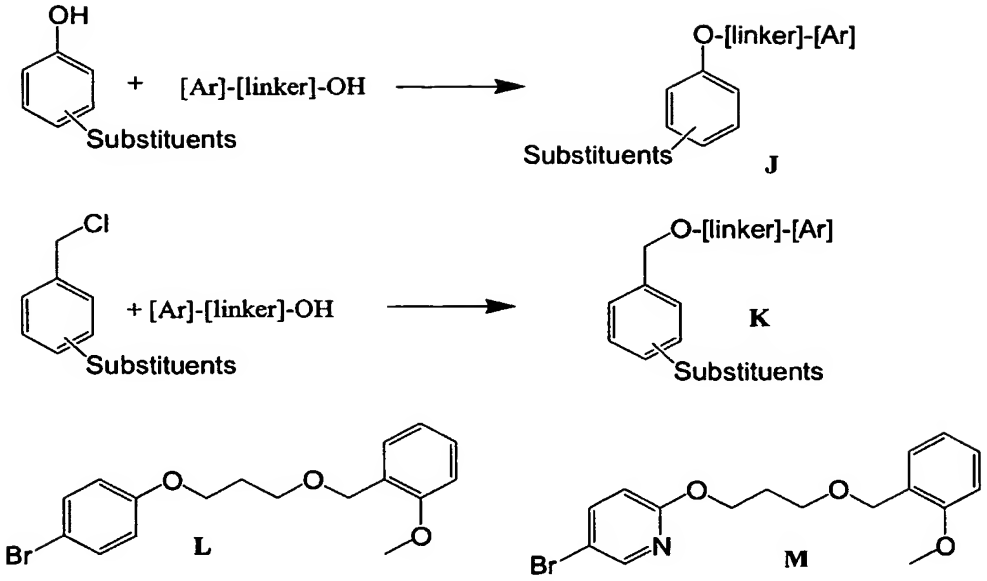
As illustrated in Scheme 1 the known compound **A** can be derivatised into the corresponding triflate **B**. A *Negishi*-type coupling (or any other coupling catalysed by a transition metal) leads to a compound of type **C** whereby R^a represents a precursor for the fragment U-V, as defined in general formula (**I**). R^a can be easily transformed into the fragment U-V using elemental chemical operations. After protecting group manipulation (→ compound of type **D**), ajustement of the W-V-U linker is possible for instance by deprotection and a *Mitsunobu*-type reaction, leading to a compound of type **E**. Hydrolysis of the ester leads to a carboxylic acid of type **F**, then an amide coupling for instance to a compound of type **G**. Removal of the Boc-protecting group and alkylation, or acylation, leads to a precursor of type **H**.

Scheme 1



The bromoaryl components can be prepared as described in Scheme 2. A *Mitsunobu* coupling (→ compounds of type **J**) or the alkylation of an alcohol with a benzylic chloride (or bromide, → compounds of type **K**) are often the most convenient methods. Derivatives **L** and **M** were prepared in one step from 1-(3-chloropropoxymethyl)-2-methoxybenzene (Vieira E. *et al.*, *Bioorg. Med. Chem. Letters*, **1999**, *9*, 1397) or 3-(5-bromopyridin-2-yloxy)propan-1-ol (Patent Application WO 98/39328) according to these methods. Other methods for the preparation of ethers or thioethers, like a *Williamson* synthesis, can be used as well (see e.g. March, J, "Advanced Organic Chemistry,", 3rd ed., John Wiley and sons, 1985).

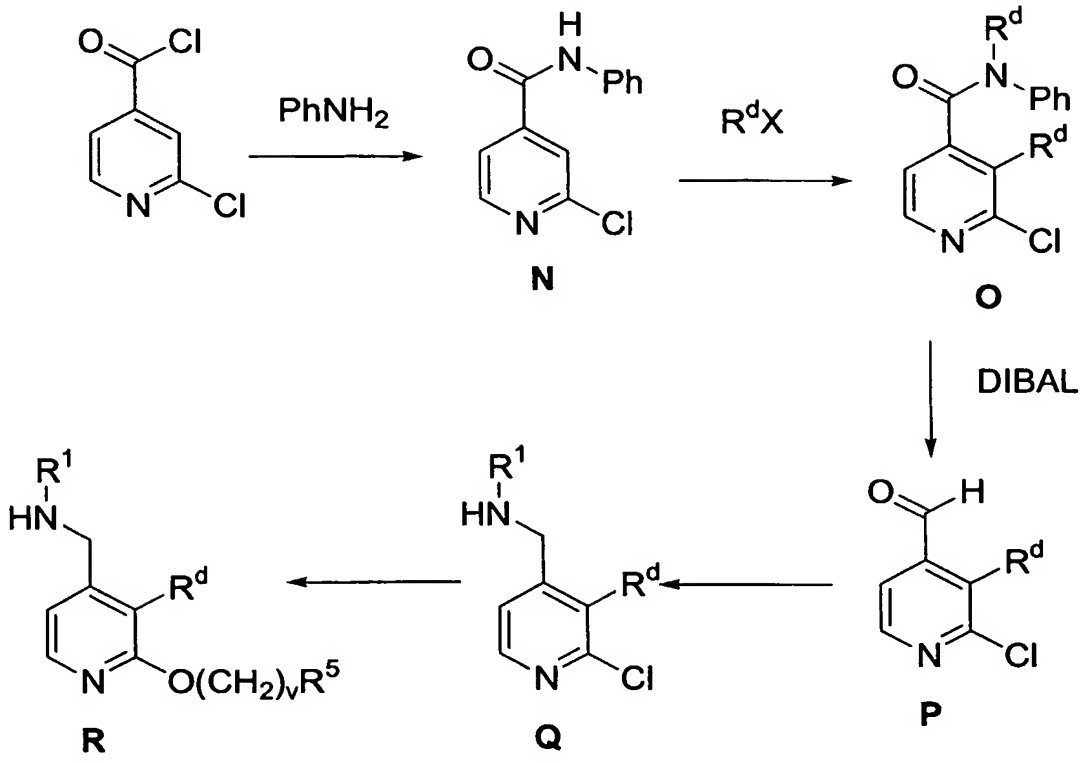
Scheme 2



Preparation of the secondary amines

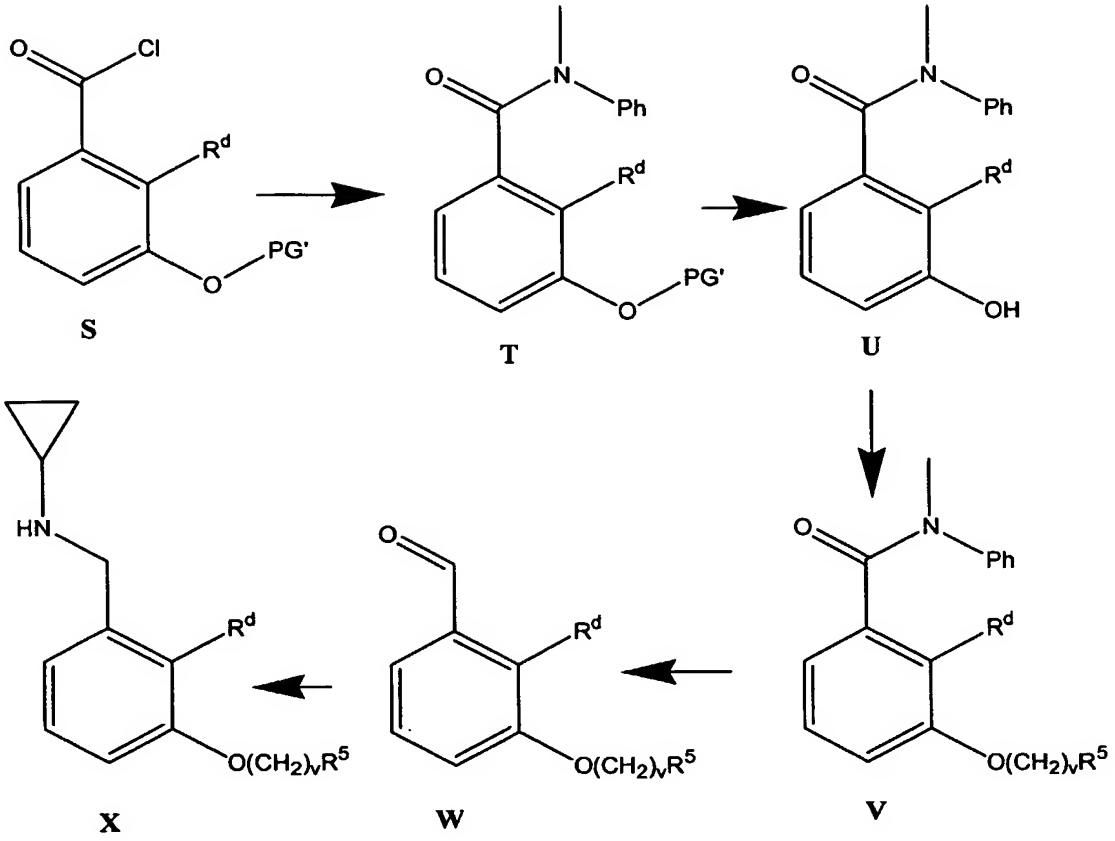
The secondary amines can be prepared for instance as described in Scheme 3. The pyridine derivative **N** can be prepared from commercially avialable 2-chloro-isonicotinoyl chloride. Deprotonation at the 3-position of this derivative, for instance with BuLi, and subsequent alkylation with a suitable electrophile leads to a derivative of type **O**, whereby R^d represents a suitable substituent that can be introduced by this chemistry, and can be transformed later into a desired substituent as described in general formula **I**. Reduction of the amide into an aldehyde with DIBAL leads to a compound of type **P**, then a reductive amination leads to an amine of type **Q**, whereas R^1 stand for a substituent as defined above. Finally substitution of the chlorine atom with an alcohol of type $HO(CH2)_vR^5$, whereas R^5 may still be protected, leads to an amine of type **R**. An alcohol of type $HO(CH_2)_2O(CH_2)_wR^5$ can be introduced in the same way.

Scheme 3



In the case of phenyl derivatives it is better to start from a compound of type **S**, wherein PG' represents a suitable protecting group. Amide coupling with *N*-methylaniline leads to a derivative of type **T**, then deprotection to a derivative of type **U**. Ether bond formation, via a *Mitsunobu*-type reaction or from a correponding alkyl halide, leads to a compound of type **V**. Reduction leads to an aldehyde of type **W**, then reductive amination to an amine of type **X**. An alcohol of type $HO(CH_2)_2O(CH_2)_wR^5$ can be introduced in the same way.

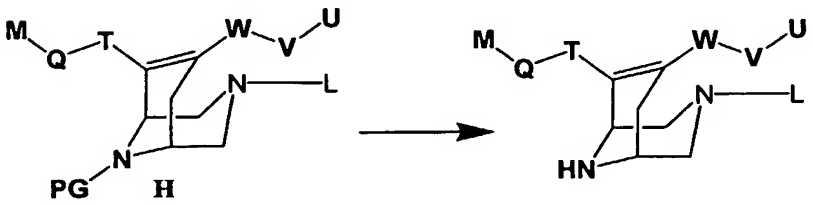
Scheme 4



Preparation of final compounds

From precursors prepared as described above, the final compounds may be prepared using parallel chemistry techniques. For the specific examples, see the experimental part. Diazabicyclononenes of type of **H** can be deprotected using standard procedures (Scheme 5). Purification by preparative HPLC might give the corresponding TFA salts or formate salts.

Scheme 5



The following examples serve to illustrate the present invention in more details. They are, however, not intended to limit its scope in any manner.

Examples

Abbreviations

ACE	Angiotensin Converting Enzyme
Ang	Angiotensin
aq.	aqueous
Boc	*tert*-Butyloxycarbonyl
BSA	Bovine serum albumine
BuLi	*n*-Butyllithium
conc.	concentrated
DIBAL	Diisobutyl aluminium hydride
DIPEA	Diisopropylethylamine
DMAP	4-*N,N*-Dimethylaminopyridine
DMF	*N,N*-Dimethylformamide
DMSO	Dimethylsulfoxide
EDC·HCl	Ethyl-*N,N*-dimethylaminopropylcarbodiimide hydrochloride
EIA	Enzyme immunoassay
Et	Ethyl
EtOAc	Ethyl acetate
FC	Flash Chromatography
HOBt	Hydroxybenzotriazol
MeOH	Methanol
org.	organic
PG	protecting group
RAS	Renin Angiotensin System
rt	room temperature
sat.	saturated
sol.	Solution
TBDMS	*tert*-Butyldimethylsilyl
Tf	Trifluoromethylsulfonyl
TFA	Trifluoroacetic acid
THF	Tetrahydrofuran

Preparation of the precursors

(*rac.*)-(*1R*, 5S)-9-Methyl-7-trifluoromethanesulfonyloxy-3,9-diazabicyclo-[3.3.1]non-6-ene-3,6-dicarboxylic acid 3-*tert*-butyl ester 6-ethyl ester (B)**

A sol. of bicyclononanone **A** (2.22 g, 6.80 mmol) in THF (50 mL) was cooled to 0 °C and NaH (about 60% in mineral oil, 326 mg, about 8.2 mmol) was added. A gas evolution was observed. After 20 min, Tf_2NPh (3.22 g, 9.00 mmol) was added. 10 min later, the ice bath was removed. After 3 h, the sol. was diluted with EtOAc and washed with brine (1x). The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification by FC (EtOAc/heptane 3:1 → EtOAc) yielded the title compound as an oil (2.50 g, 80%). R_f = 0.15 (EtOAc/heptane 1:1). LC-MS: R_t = 4.73; ES+: 458.95.

(*rac.*)-(*1R*, 5S)-7-{4-[3-(*tert*-Butyldimethylsilanyloxy)propyl]phenyl}-9-methyl-3,9-diazabicyclo[3.3.1]non-6-ene-3,6-dicarboxylic acid 3-*tert*-butyl ester 6-ethyl ester (C1)**

A solution of [3-(4-bromophenyl)propoxy]-*tert*-butyldimethylsilane (Kiesewetter D. O., *Tetrahedron Asymmetry*, **1993**, *4*, 2183, 46.11 g, 0.140 mol) in dry THF (750ml) was cooled to –78°C. BuLi (1.6M in hexane, 96mL, 143 mmol) was added, and the reaction mixture was stirred for 1 h at –78°C. $ZnCl_2$ (1M in THF, 210mL, 210 mmol) was added, and the solution was allowed to warm up to rt. Vinyl triflate **B** (31.1 g, 70.0 mmol) and $Pd(PPh_3)_4$ (2.03 g, 1.75 mmol) were added and the mixture was heated to reflux. After 6 h the mixture was allowed to cool to rt. The mixture was diluted with EtOAc (2000 mL) and washed with aq. 1M NaOH (~1000mL). The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the crude by FC (CH_2Cl_2 / MeOH; 49:1 ? 45:5) yielded the title compound (33.02 g, 84%).

(*rac.*)-(*1R*, 5S)-7-{4-[2-(*tert*-Butyldimethylsilanyloxy)ethoxy]phenyl}-9-methyl-3,9-diazabicyclo[3.3.1]non-6-ene-3,6-dicarboxylic acid 3-*tert*-butyl ester 6-ethyl ester (C2)**

A solution of [2-(4-bromophenoxy)ethoxy]-*tert*-butyldimethylsilane (Morita, C.; et al.al.; *Heterocycles*, **2000**, *52*, 1163; 47.7 g, 0.144 mol) in dry THF (650mL) was cooled to –78°C. BuLi (1.6M in hexane, 92.2 mL, 147 mmol) was added, and the reaction mixture was stirred for 1 h at –78°C. $ZnCl_2$ (0.83 M in THF, 260 mL, 216 mmol) was added, and the solution was allowed to warm up to rt. Vinyl triflate **B** (33.0 g, 72.0 mmol) in THF (100 mL) and $Pd(PPh_3)_4$ (2.08 g, 1.80 mmol) were added and the mixture was heated to

reflux. After 30 min the mixture was allowed to cool to rt. The mixture was diluted with EtOAc and washed with aq. 1M NaOH. The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the crude by FC (CH_2Cl_2 / MeOH; 49:1 ? 45:5) yielded the title compound (33.9 g, 84%).

(*rac.*)-(*1R*, 5S)-7-[4-(3-Hydroxypropyl)phenyl]-3,9-diazabicyclo[3.3.1]non-6-ene-3,6,9-tricarboxylic acid 3,9-di-*tert*-butyl ester 6-ethyl ester (D1)**

1–Chloroethyl chloroformate (50.8 mL, 470 mmol) and $NaHCO_3$ (39.5 g, 470 mmol) were added to a sol. of bicyclnonene **C1** (26.3 g, 57.0 mmol) in 1,2-dichloroethane (450 mL). The sol. was heated to reflux. After 3 h, the reaction mixture was allowed to cool to rt, filtered, and the solvents were removed under reduced pressure. MeOH (210 mL) was added. The mixture was stirred at 60 °C for 60 min, and the solvents were removed under reduced pressure. The residue was dissoled in CH_2Cl_2 (460 mL), DIPEA (40.3 mL, 235 mmol) was added, and the mixture was cooled to 0 °C. Boc_2O (30.8 g, 141 mmol) was added and the mixture was stirred at 0 °C for 1 h, then at rt overnight. The mixture was washed with aq. 1M HCl (1x), and aq. sat. $NaHCO_3$ (1x). The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the residue by FC yielded the title compound (13.6 g, 54%).

(*rac.*)-(*1R*, 5S)-7-[4-(2-Hydroxyethoxy)phenyl]-3,9-diazabicyclo[3.3.1]non-6-ene-3,6,9-tricarboxylic acid 3,9-di-*tert*-butyl ester 6-ethyl ester (D2)**

1–Chloroethyl chloroformate (51.7 mL, 474 mmol) and $NaHCO_3$ (40.0 g, 474 mmol) were added to a sol. of bicyclnonene **C2** (26.6 g, 47.4 mmol) in 1,2-dichloroethane (500 mL). The sol. was heated to reflux. After 3 h, the reaction mixture was allowed to cool to rt, filtered, and the solvents were removed under reduced pressure. MeOH (500 mL) was added. The mixture was stirred at 50 °C for 20 min, and the solvents were removed under reduced pressure. The residue was dissoled in CH_2Cl_2 (500 mL), DIPEA (40.6 mL, 237 mmol) was added, and the mixture was cooled to 0 °C. Boc_2O (31.4 g, 142 mmol) was added and the mixture was stirred at 0 °C for 1 h, then at rt for 2 h. The mixture was washed with aq. 1M HCl (1x), and aq. sat. $NaHCO_3$ (1x). The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the residue by FC yielded the title compound (16.6 g, 66%).

(*rac.*)-(*1R*, 5S)-7-{4-[3-(2-Chloro-3,6-difluorophenoxy)propyl]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-3,6,9-tricarboxylic acid 3,9-di-*tert*-butyl ester 6-ethyl ester (E1)**

To a sol. of compound **D1** (16.45 g, 30.9 mmol) in dry toluene (350 mL) was added 2-chloro-3,6-difluorophenol (10.2 g, 62 mmol), azodicarboxylic dipepiridide (15.65 g, 62 mmol) and tributylphosphine (85%, 24.15 mL, 93 mmol). The mixture was heated to reflux for 1 h and allowed to cool to rt. The mixture was diluted with EtOAc, and washed with aq. 1M NaOH (2x). The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the residue by FC (EtOAc / heptane 5% ? 1:1) yielded the title compound (20.2 g, 96%) as a yellow oil.

(*rac.*)-(*1R*, 5S)-7-{4-[2-(2,6-Dichloro-4-methylphenoxy)ethoxy]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-3,6,9-tricarboxylic acid 3,9-di-*tert*-butyl ester 6-ethyl ester (E2)**

To a sol. of compound **D2** (16.6 g, 30.2 mmol) in dry toluene (500 mL) was added 2,6-dichloro-*p*-cresol (11.1 g, 62.5 mmol), azodicarboxylic dipepiridide (15.8 g, 62.5 mmol) and tributylphosphine (85%, 27.2 mL, 93.7 mmol). The mixture was heated to reflux for 4 h and allowed to cool to rt. The mixture was diluted with EtOAc and washed with aq. 1M NaOH (2x). The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the residue by FC (EtOAc / heptane 5% ? 1:1) yielded the title compound (12.3 g, 57%) as a yellow oil.

(*rac.*)-(*1R*, 5S)-7-{4-[3-(2-Chloro-3,6-difluorophenoxy)propyl]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-3,6,9-tricarboxylic acid 3,9-di-*tert*-butyl ester (F1)**

A sol. of compound **E1** (12.3 g, 17.8 mmol) in EtOH (860 mL) and aq. 1M NaOH (370 mL) was stirred at 80°C overnight. The reaction mixture was partially concentrated under reduced pressure, and the residue was acidified with aq. 3M HCl. The mixture was extracted with EtOAc (3x). The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. The residue was used without further purification.

(*rac.*)-(*1R*, 5S)-7-{4-[2-(2,6-Dichloro-4-methylphenoxy)ethoxy]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-3,6,9-tricarboxylic acid 3,9-di-*tert*-butyl ester (F2)**

A sol. of compound **E2** (20.17 g, 29.8 mmol) in EtOH (1000 mL) and aq. 1M NaOH (550 mL) was stirred at 80°C for 5 h. The reaction mixture was partially concentrated under reduced pressure, and the residue was acidified with aq. 1M HCl. The mixture was extracted with EtOAc (3x). The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. The residue was used without further purification.

(*rac.*)-(*1R*, 5S)-6-({2-[2-(*tert*-Butyldimethylsilanyloxy)ethoxy]-3-methyl-pyridin-4-ylmethyl}cyclopropylcarbamoyl)-7-{4-[3-(2-chloro-3,6-difluoro-phenoxy)propyl]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-3,9-dicarboxylic acid di-*tert*-butyl ester (G1)**

A sol. of compound **F1** (45.5 mg, 0.070 mmol), amine **R1** (71 mg, 0.21 mmol), HOBt (12 mg, 0.088 mmol), EDC·HCl (34 mg, 0.175 mmol) DIPEA (0.048 ml, 0.28 mmol) and DMAP (2.1 mg, 0.18 mmol) in CH_2CL_2 (2 mL) was stirred at rt for 24 h. EDC·HCl (27 mg, 0.14 mmol) and DIPEA (0.012 mL, 0.07 mmol) were added again, and the mixture was stirred at rt for 7 h. One more time EDC·HCl (27 mg, 0.14 mmol) and DIPEA (0.012 mL, 0.07 mmol) were added and the mixture was stirred at rt for additional 4 days. The mixture was loaded over an Isolute® column (pre-conditionned with aq. 1M HCl, 1 mL). The column was washed with CH_2Cl_2 (4 mL), and the org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. The crude (106 mg) was used in the next reaction without purification. LC-MS:R_T = 1.35 min; ES^+ = 967.5.

(*rac.*)-(*1R*, 5S)-6-({2-[3-(*tert*-Butyldimethylsilanyloxy)propoxy]-3-methyl-pyridin-4ylmethyl}cyclopropylcarbamoyl)-7-{4-[3-(2-chloro-3,6-difluoro-phenoxy)propyl]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-3,9-dicarboxylic acid di-*tert*-butyl ester (G2)**

As described for compound **G1**, but from compound **F1** (45.5 mg, 0.070 mmol), amine **R2** (74 mg, 0.21 mmol), DIPEA (0.048 mL, 0.28 mmol), DMAP (2.1 mg, 0.018 mmol), HOBt (12 mg, 0.088 mmol), EDC·HCl (34 mg, 0.175 mmol) and CH_2Cl_2 (2 mL). The crude (94 mg) was used in the next reaction without purification. LC-MS:R_T = 1.36 min.

(*rac.*)-(*1R*, 5S)-6-({2-[2-(*tert*-Butyldimethylsilanyloxy)ethoxy]-3-methyl-pyridin-4-ylmethyl}cyclopropylcarbamoyl)-7-{4-[2-(2,6-dichloro-4-methyl-phenoxy)ethoxy]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-3,9-dicarboxylic acid di-*tert*-butyl ester (G3)**

As described for compound **G1**, but from compound **F2** (46.5 mg, 0.070 mmol), amine **R1** (71 mg, 0.21 mmol), DIPEA (0.048 mL, 0.28 mmol), DMAP (2.1 mg, 0.018 mmol), HOBt (12 mg, 0.088 mmol), EDC·HCl (34 mg, 0.175 mmol) and CH_2Cl_2 (2 mL). The crude (94 mg) was used in the next reaction without purification. LC-MS:R_T = 1.35 min.

(*rac.*)-(*1R*, 5S)-6-({2-[3-(*tert*-Butyldimethylsilanyloxy)propoxy]-3-methyl-pyridin-4-ylmethyl}cyclopropylcarbamoyl)-7-{4-[2-(2,6-dichloro-4-methyl-phenoxy)ethoxy]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-3,9-dicarboxylic acid di-*tert*-butyl ester (G4)**

As described for compound **G1**, but from compound **F2** (46.5 mg, 0.070 mmol), amine **R2** (74 mg, 0.21 mmol), DIPEA (0.048 mL, 0.28 mmol), DMAP (2.1 mg, 0.018 mmol), HOBt (12 mg, 0.088 mmol), EDC·HCl (34 mg, 0.175 mmol) and CH_2Cl_2 (2 mL). The crude (94 mg) was used in the next reaction without purification. LC-MS:R_T = 1.36 min.

2-Chloro-N-phenylisonicotinamide (N)

To the sol. of 2-chloro-isonicotinoyl chloride (Anderson, W. K., Dean, D. C., Endo, T., *J. Med. Chem.*, **1990**, *33*, 1667, 10 g, 56.8 mmol) in 1,2-dichloroethane (100 mL) was added at 0 °C a sol. of aniline (5.70 mL, 62.5 mmol) and DIPEA (10.2 ml, 59.6 mmol) in 1,2-dichloroethane (10 ml) during ca. 30 min. The reaction was stirred at 0 °C for ca. 30 min and subsequently for 1 h at 95 °C. Water (30 mL) was added at rt and the mixture was filtered-off. The filtrate was extracted with CH_2Cl_2 (200 mL). The combined org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. The residue was crystallized from MeOH/water 1:10 (110 mL), yielding the title compound (12.12 g, 92%). LC-MS: R_T = 0.87 min; ES^+ = 233.1.

2-Chloro-3-*N*-dimethyl-*N*-phenylisonicotinamide (O)

To a sol. of compound **N** (8.79g, 37.8 mmol) in THF (90 mL) was added BuLi (1.6M in hexane, 52 mL, 83.2 mmol) at –78°C. After 30 min MeI (7.70 mL, 124 mmol) was added dropwise at the same temperature. The mixture was stirred at –78 °C for 1 h, and was

warmed up to 33 °C. The mixture was stirred at 33 °C for 30 min. Aq. 10% NH_4OH was added dropwise at rt, and the mixture was extracted with Et_2O. The org. extracts were dried over $MgSO_4$, filtered, and the solvents were evaporated under reduced pressure. Purification by FC yielded the title compound (8.67 g, 88%). LC-MS:R_T = 0.85 min; ES^+ = 261.2.

2-Chloro-3-methylpyridine-4-carbaldehyde (P)

To the sol. of pyridine derivative **O** (9.58 g, 36.7 mmol) in CH_2Cl_2 (190 mL) was at –78 °C added DIBAL (1M in CH_2Cl_2, 55.1 mL, 55.1 mmol), and the mixture was stirred at –78 °C for 1.5 h. Aq. sat. tartaric acid monosodium monokalium salt in water (20 ml) was added and the mixture was allowed to warm up to rt. Water was added and the mixture was extracted with CH_2Cl_2. The org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the residue by FC yielded the title compound (4.4 g, 77%). LC-MS:R_T = 0.76 min; ES^+ = 156.1.

(2-Chloro-3-methylpyridin-4-ylmethyl)-cyclopropylamine (Q)

A sol. of aldehyde **P** (4.70 g, 30.2 mmol) and cyclopropylamine (4.20 ml, 60.4 mmol) in MeOH (65 mL) was stirred at rt for 4 h. $NaBH_4$ (1.55 g, 39.2 mmol) was added and the mixture was stirred at rt for 12 h. Water and subsequently aq. 1M NaOH were added, and the solvents were partially removed under reduced pressure. The water phase was extracted with CH_2Cl_2 (2x). The combined org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the crude by FC yielded the title compound (4.66 g, 79%). LC-MS:R_T = 0.43 min; ES^+ = 197.1.

{2-[2-(*tert*-Butyldimethylsilanyloxy)ethoxy]-3-methylpyridin-4-ylmethyl}-cyclopropylamine (R1)

A sol. of amine **Q** (1.30 g, 6.61 mmol) and 2-(*tert*-butyldimethylsilanyloxy)-ethanol (423 mg, 10.58 mmol) in dioxan (5 ml) was heated at 115 °C for 12 h. The solvents were removed under reduced pressure, water was added, and the mixture was extracted with Et_2O (2x). The combined org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the crude by FC yielded the title compound (926 mg, 42%). LC-MS:R_T = 0.79 min; ES^+ = 337.3.

{2-[3-(*tert*-Butyldimethylsilanyloxy)propoxy]-3-methylpyridin-4-ylmethyl}-cyclopropylamine (R2)

A sol. of amine **Q** (1.24 g, 6.30 mmol) and 2-(*tert*-butyldimethylsilanyloxy)-propan-1-ol (403 mg, 10.1 mmol) in dioxan (5 ml) was heated at 115 °C for 12 h. The solvents were removed under reduced pressure, water was added, and the mixture was extracted with Et_2O (2x). The combined org. extracts were dried over $MgSO_4$, filtered, and the solvents were removed under reduced pressure. Purification of the crude by FC yielded the title compound (192 mg, 9%). LC-MS:R_T = 0.84 min; ES^+ = 351.4.

Preparation of the final compounds

Example 1

***(rac.)*-(*1R**, *5S**)-7-{4-[3-(2-Chloro-3,6-difluorophenoxy)propyl]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-6-carboxylic acid cyclopropyl-[2-(3-hydroxy-propoxy)-3-methylpyridin-4-ylmethyl]amide**

To a sol. compound **G2** (106 mg, ca. 0.07 mmol) in CH_2Cl_2 (1 ml) was added 4M HCl in dioxane (1 mL) at 0 °C, and the mixture was stirred at rt for 2 h. The solvents were removed under reduced pressure and the crude was dried under high vacuum. Purification of the crude by HPLC yielded the title compound (12.6 mg, 24 %). LC-MS: R_T = 0.78 min; ES^+ = 667.43.

Example 2

***(rac.)*-(*1R**, *5S**)-7-{4-[2-(2,6-Dichloro-4-methylphenoxy)ethoxy]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-6-carboxylic acid cyclopropyl-[2-(3-hydroxy-propoxy)-3-methylpyridin-4-ylmethyl]amide**

To a sol. compound **G4** (166 mg, ca. 0.07 mmol) in CH_2Cl_2 (1 ml) was added 4M HCl in dioxane (1 mL) at 0 °C, and the mixture was stirred at rt for 2 h. The solvents were removed under reduced pressure and the crude was dried under high vacuum. Purification of the crude by HPLC yielded the title compound (12.6 mg, 24 %). LC-MS: R_T = 0.78 min; ES^+ = 681.41.

Example 3

(*rac.*)-(*1R, *5S**)-7-{4-[3-(2-Chloro-3,6-difluorophenoxy)propyl]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-6-carboxylic acid cyclopropyl-[2-(2-hydroxy-ethoxy)-3-methylpyridin-4-ylmethyl]amide**

To a sol. compound **G1** (106 mg, ca. 0.07 mmol) in CH_2Cl_2 (1 ml) was added 4M HCl in dioxane (1 mL) at 0 °C, and the mixture was stirred at rt for 2 h. The solvents were removed under reduced pressure and the crude was dried under high vacuum. Purification of the crude by HPLC yielded the title compound (12.6 mg, 24 %). LC-MS: R_T = 0.77 min; ES^+ = 653.39.

Example 4

(*rac.*)-(*1R, *5S**)-7-{4-[2-(2,6-Dichloro-4-methylphenoxy)ethoxy]phenyl}-3,9-diazabicyclo[3.3.1]non-6-ene-6-carboxylic acid cyclopropyl-[2-(2-hydroxy-ethoxy)-3-methylpyridin-4-ylmethyl]amide**

To a sol. compound **G3** (166 mg, ca. 0.07 mmol) in CH_2Cl_2 (1 ml) was added 4M HCl in dioxane (1 mL) at 0 °C, and the mixture was stirred at rt for 2 h. The solvents were removed under reduced pressure and the crude was dried under high vacuum. Purification of the crude by HPLC yielded the title compound (12.6 mg, 24 %). LC-MS: R_T = 0.77 min; ES^+ = 667.41.

The following assay was carried out in order to determine the activity of the compounds of general formula **I** and their salts.

Inhibition of human recombinant renin by the compounds of the invention

The enzymatic in vitro assay was performed in 384-well polypropylene plates (Nunc). The assay buffer consisted of 10 mM PBS (Gibco BRL) including 1 mM EDTA and 0.1% BSA. The incubates were composed of 50 µL per well of an enzyme mix and 2.5 µL of renin inhibitors in DMSO. The enzyme mix was premixed at 4°C and consists of the following components:

- human recombinant renin (0.16 ng/mL)
- synthetic human angiotensin(1-14) (0.5 µM)
- hydroxyquinoline sulfate (1 mM)

The mixtures were then incubated at 37°C for 3 h.

To determine the enzymatic activity and its inhibition, the accumulated Ang I was detected by an enzyme immunoassay (EIA) in 384-well plates (Nunc). 5 µL of the incubates or standards were transferred to immuno plates which were previously coated with a covalent

complex of Ang I and bovine serum albumin (Ang I – BSA). 75 µL of Ang I-antibodies in essaybuffer above including 0.01% Tween 20 were added and a primary incubation made at 4 °C overnight. The plates were washed 3 times with PBS including 0.01% Tween 20, and then incubated for 2 h at rt with an antirabbit-peroxidase coupled antibody (WA 934, Amersham). After washing the plates 3 times, the *peroxidase substrate* ABTS (2.2'-azino-di-(3-ethyl-benzthiazolinsulfonate), was added and the plates incubated for 60 min at room temperature. After stopping the reaction with 0.1 M citric acid pH 4.3 the plate was evaluated in a microplate reader at 405 nm. The percentage of inhibition was calculated of each concentration point and the concentration of renin inhibition was determined that inhibited the enzyme activity by 50% (IC_{50}). The IC_{50}-values of all compounds tested are below 100 nM. However selected compounds exhibit a very good bioavailibility and are metabolically more stable than prior art compounds.

Examples of inhibition:

Example 1: 1.16 nM

Example 2: 0.49 nM

Example 3: 0.82 nM

Example 4: 1.43 nM